(12) UK Patent Application (19) GB (11) 2 270 292 (13) A

(43) Date of A Publication **09.03.1994**

(21) Application No **9316482.0**

(22) Date of Filing **09.08.1993**

(30) Priority Data
(31) **04236825** (32) **04.09.1992** (33) **JP**

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(51) INT CL^5
B66B 17/12

(52) UK CL (Edition M)
B8B BDD BGC
B8L LFP L24
U1S S1872

(56) Documents Cited
GB 1584475 A **GB 1440895 A**

(58) Field of Search
UK CL (Edition L) **B8B BDD BGC , B8L LFP**
INT CL^5 **B66B**
Online database : WPI

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(54) Lift with vibration damping counterweight

(57) A vibration preventing device for a lift is arranged such that a main rope (3) is trained around a sheave (1) of a hoisting motor and a deflector wheel (2) disposed on the side of the sheave (1), the main rope (3) is connected to the upper sides of a passenger cage (6) and a counterweight, respectively, by a thimble rod spring (5a) through a thimble rod (4a), a compensating rope (11) is attached to the lower sides of the passenger cage (6) and the counterweight by a thimble rod spring (5b) through a thimble rod (4b) and trained around a compensating pulley (12), and a counterweight includes a vibration damping means (8a, b, 9a, b) for suppressing a vibration mode caused by the rotation of the sheave (1) and the compensating pulley (12). The counterweight preferably includes a plurality of mass members which are connected to each other by vibration damping means each composed of an elastic member (8a, b) and a damping member (9a, b). Fig 9 shows an alternative vibration tamping arrangement with a rope which is fixed at its ends and supports the lift and counterweight by respective pulleys.

FIG. I

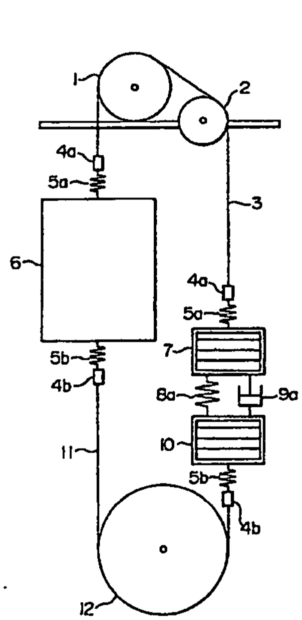

FIG. 9

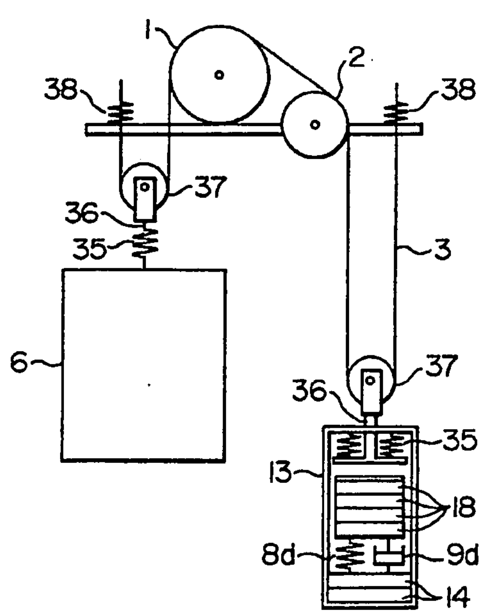

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FIG. 1

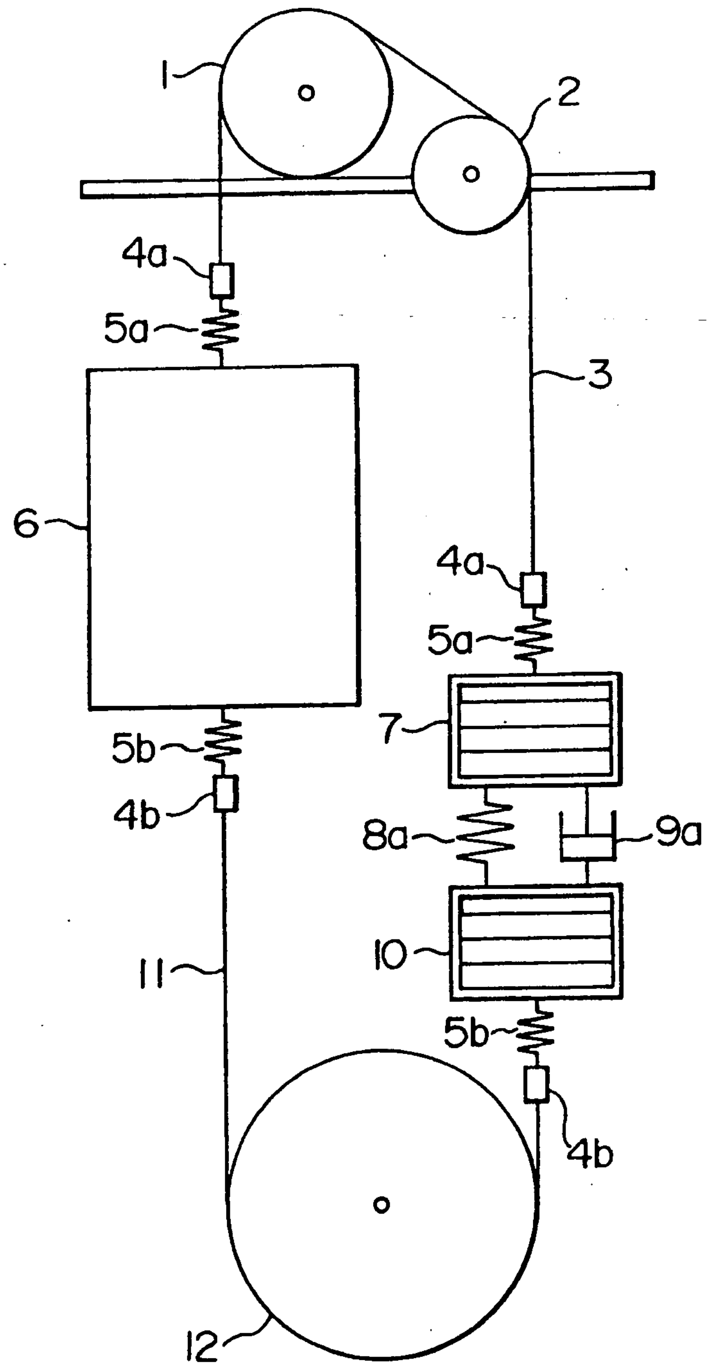


FIG. 2

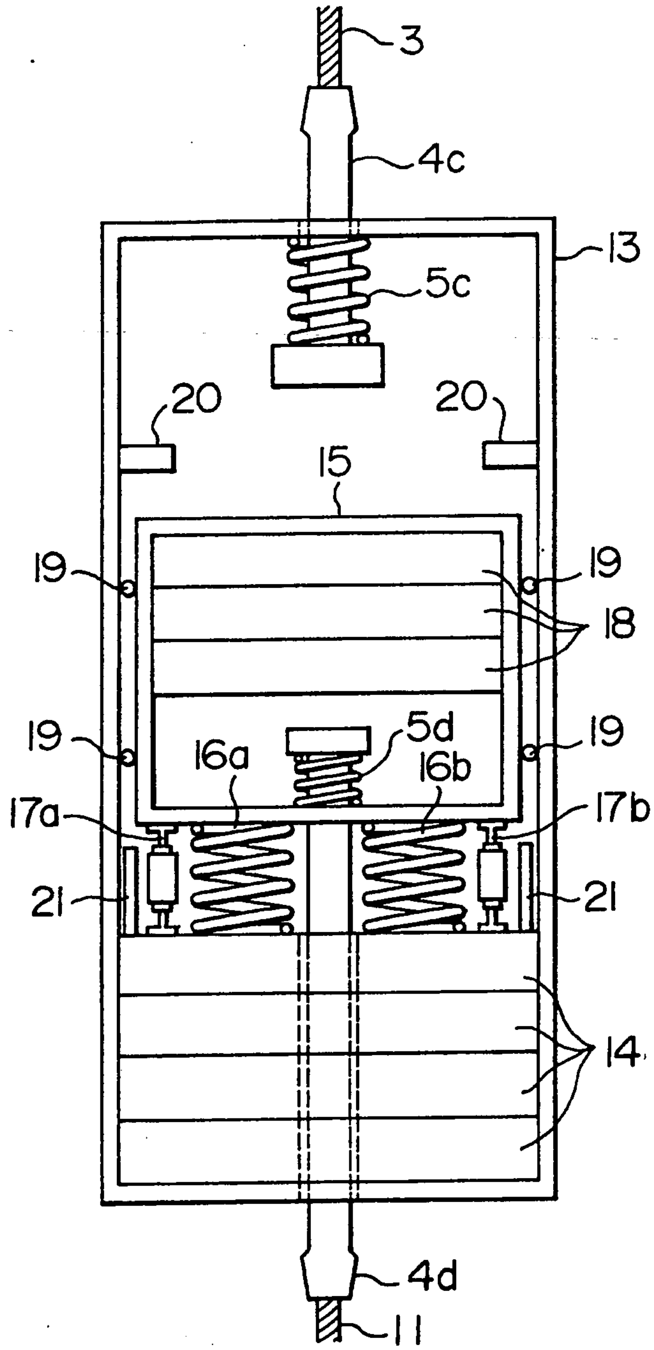


FIG. 3

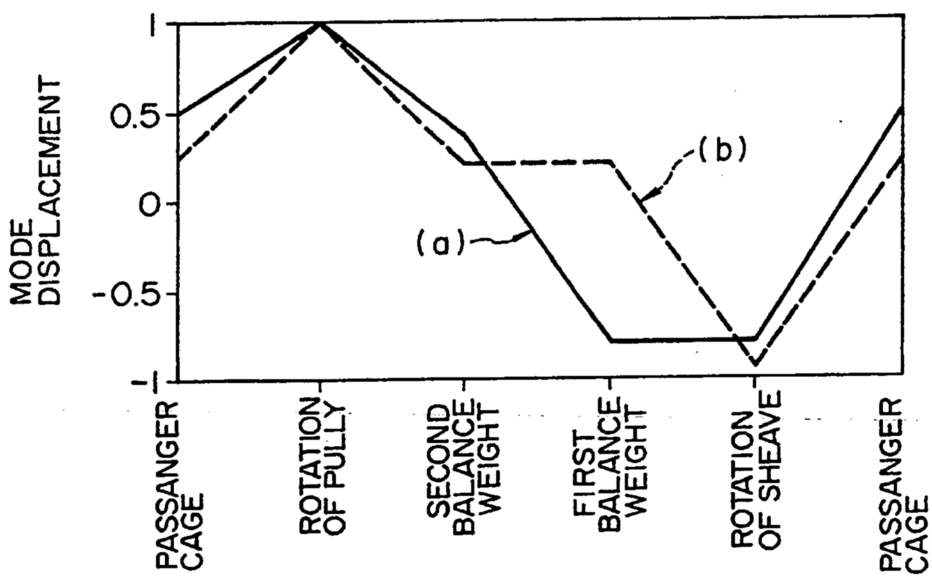

MODE DISPLACEMENT
1
0.5
0
-0.5
-1
(a)
(b)
PASSANGER CAGE
ROTATION OF PULLY
SECOND BALANCE WEIGHT
FIRST BALANCE WEIGHT
ROTATION OF SHEAVE
PASSANGER CAGE

FIG. 4

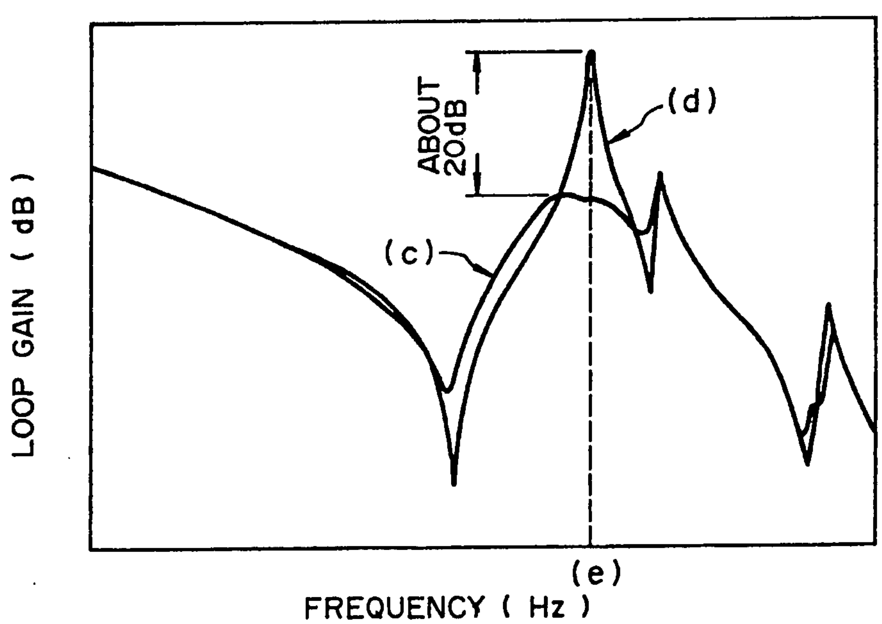

LOOP GAIN (dB)
ABOUT 20dB
(d)
(c)
(e)
FREQUENCY (Hz)

FIG. 5

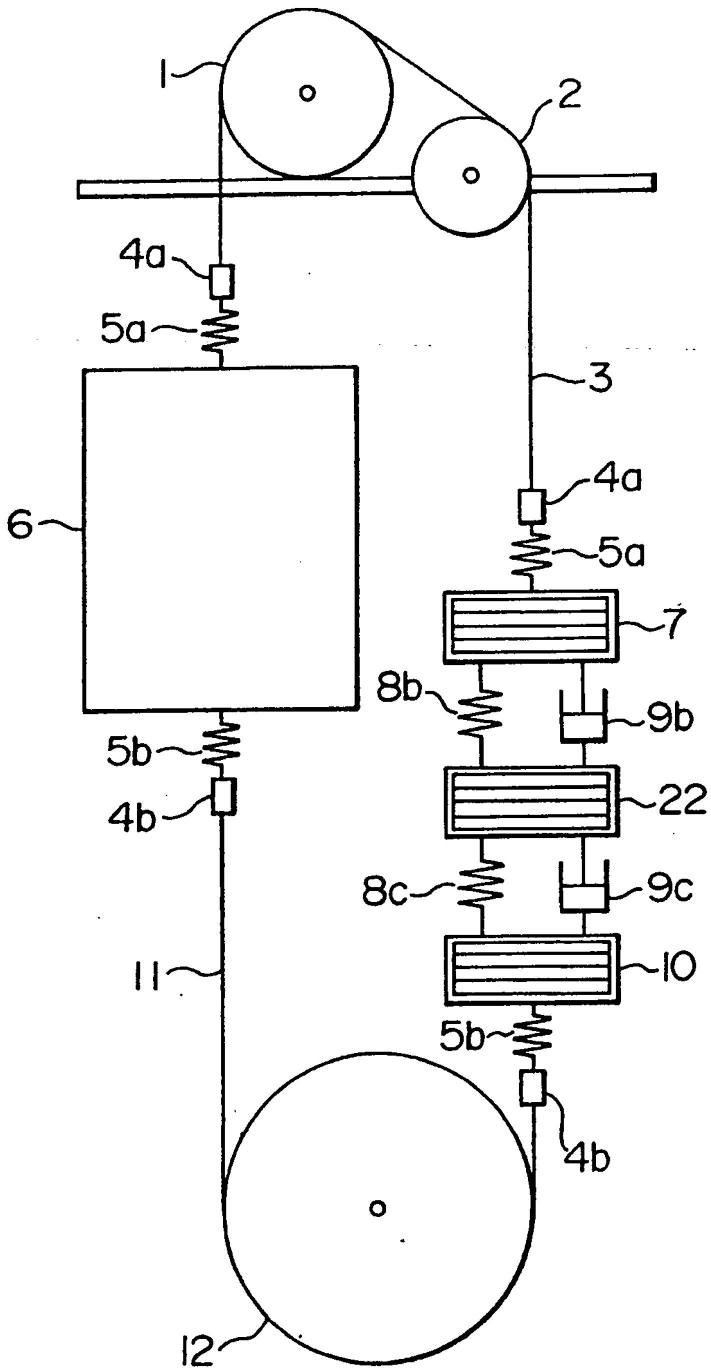


FIG. 6

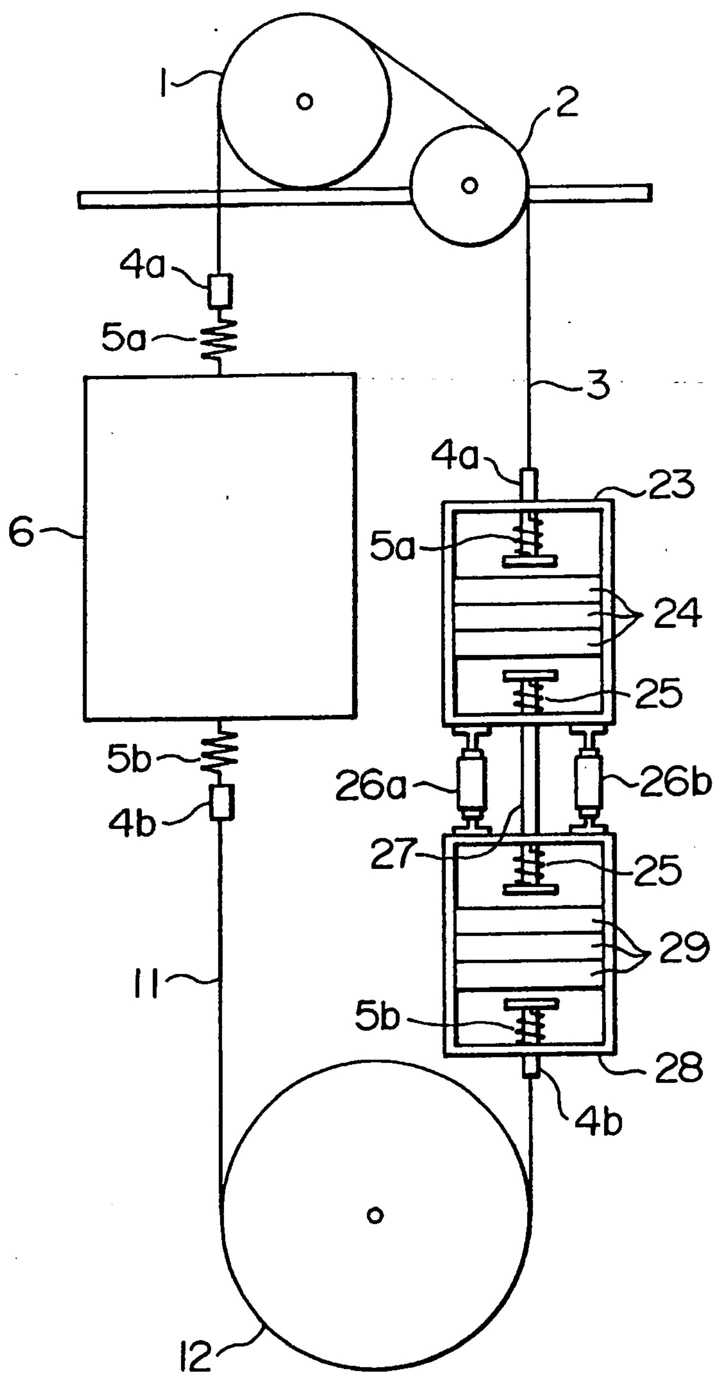


FIG. 7

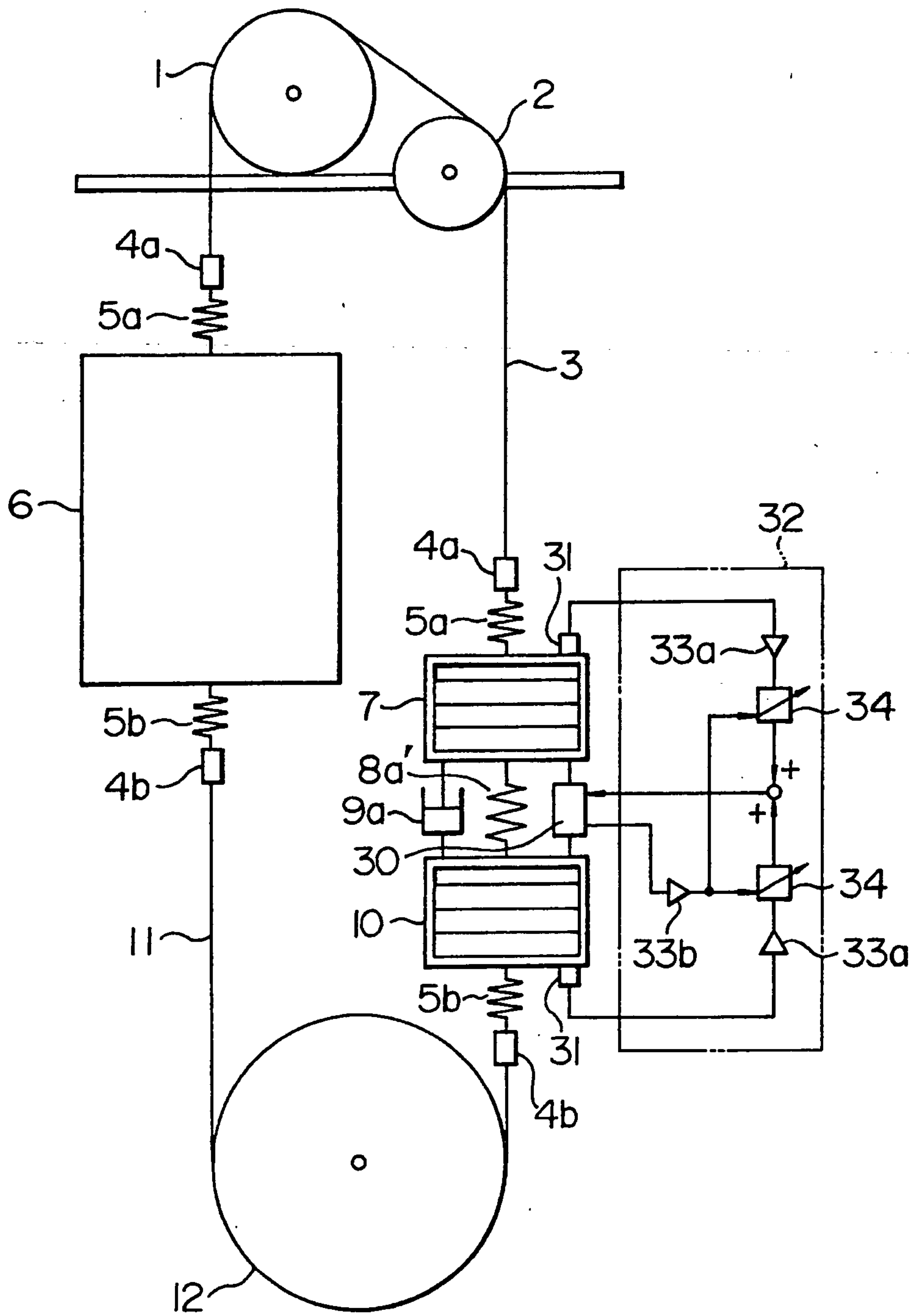

1
2
4a
5a
3
6
4a
31
32
5a
33a
7
34
8a'
+
9a
+
30
34
10
33b
33a
11
5b
4b
5b
31
4b
12

FIG. 8

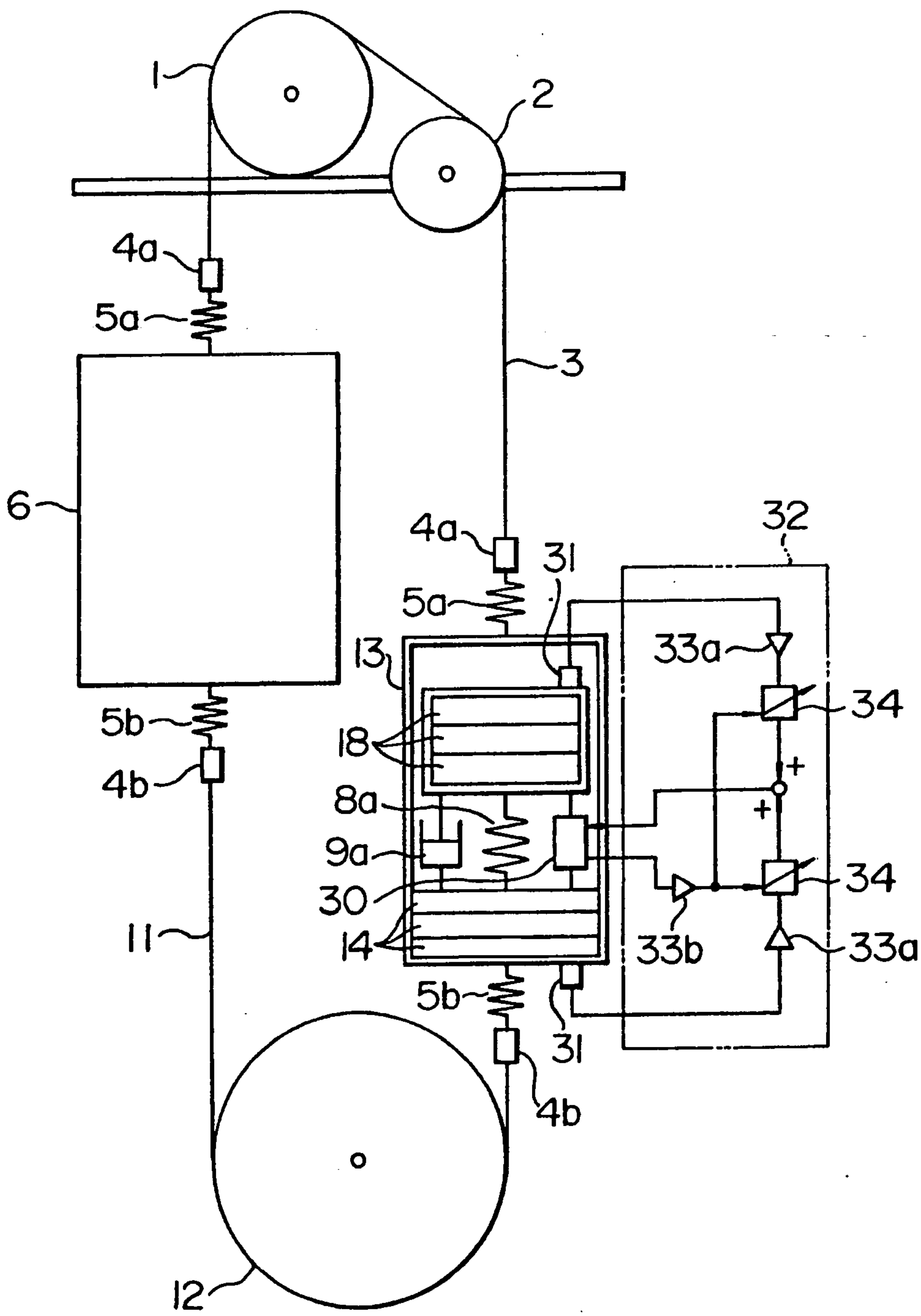

1
2
3
4a
5a
6
5b
4b
11
12
4a
5a
31
32
33a
34
13
18
8a
9a
30
14
+
+
33b
5b
31
4b
33a

FIG. 9

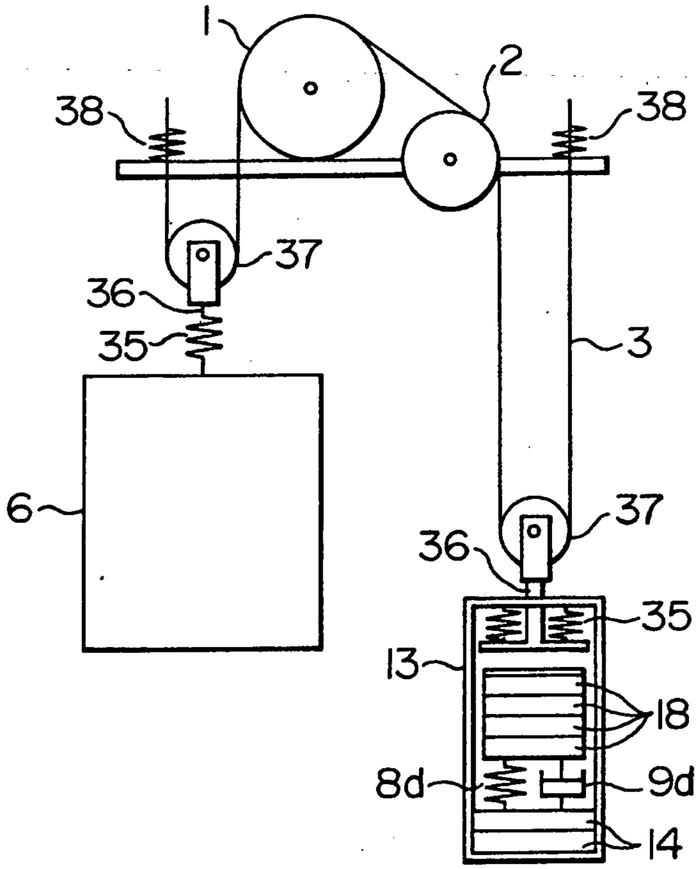


FIG. 10

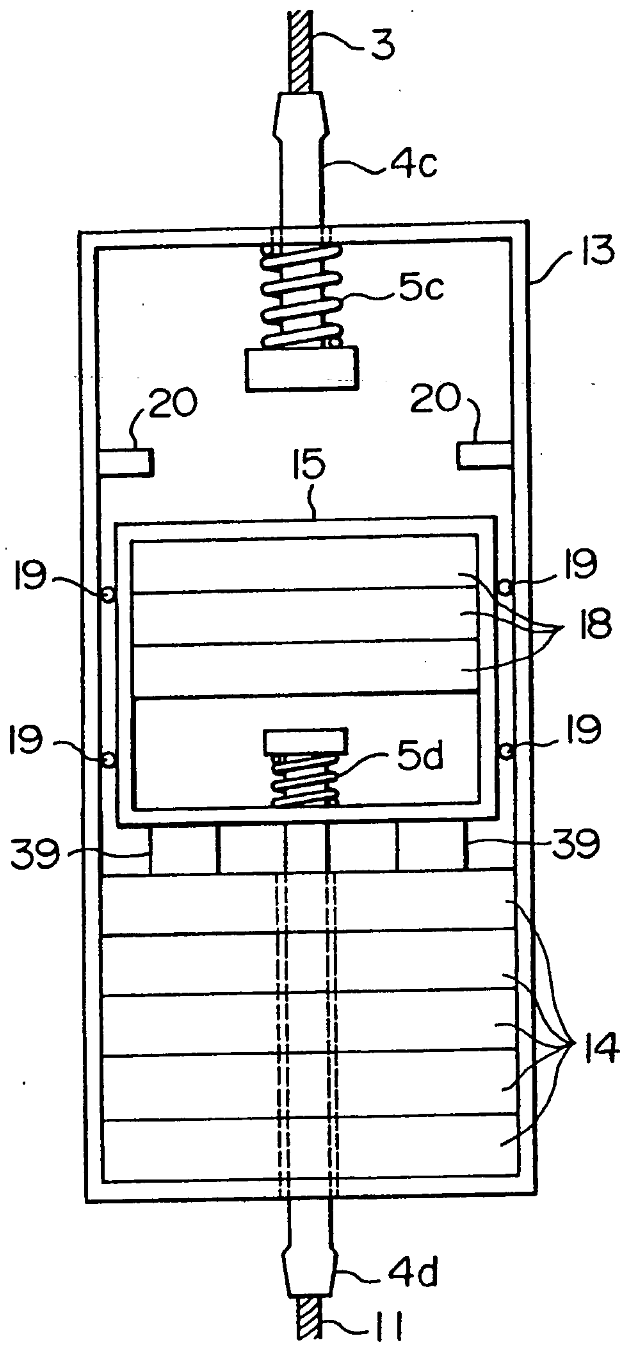


FIG. 11

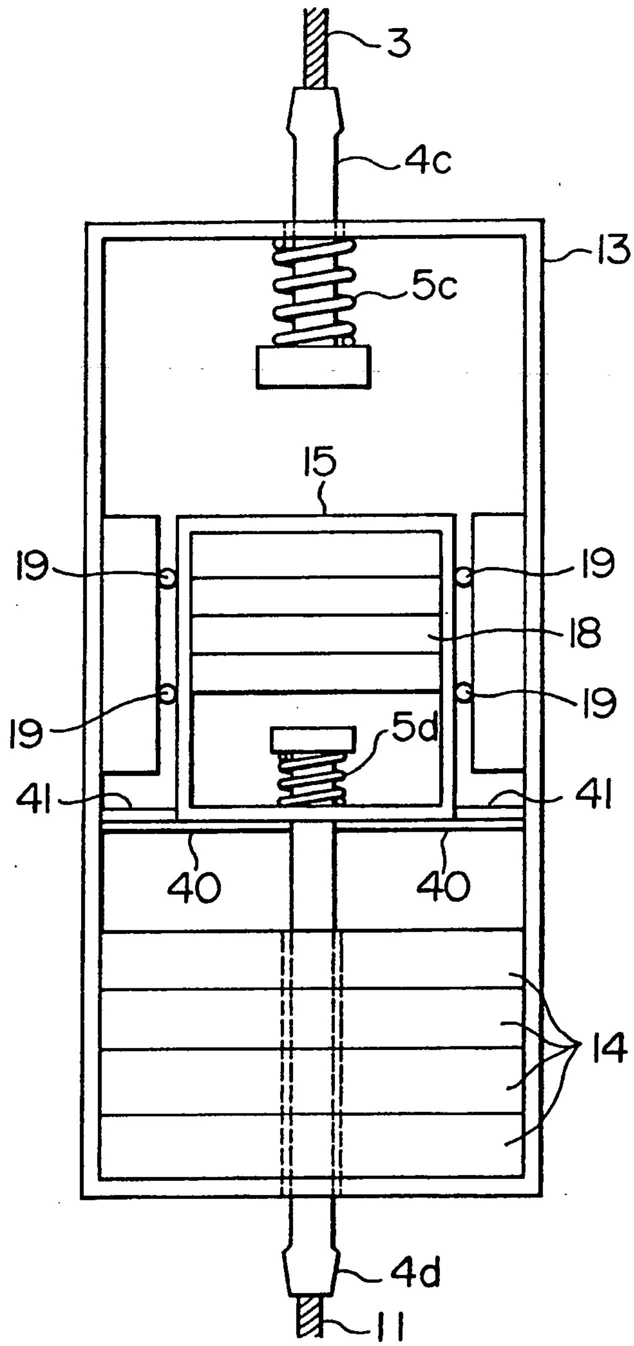


FIG. 12

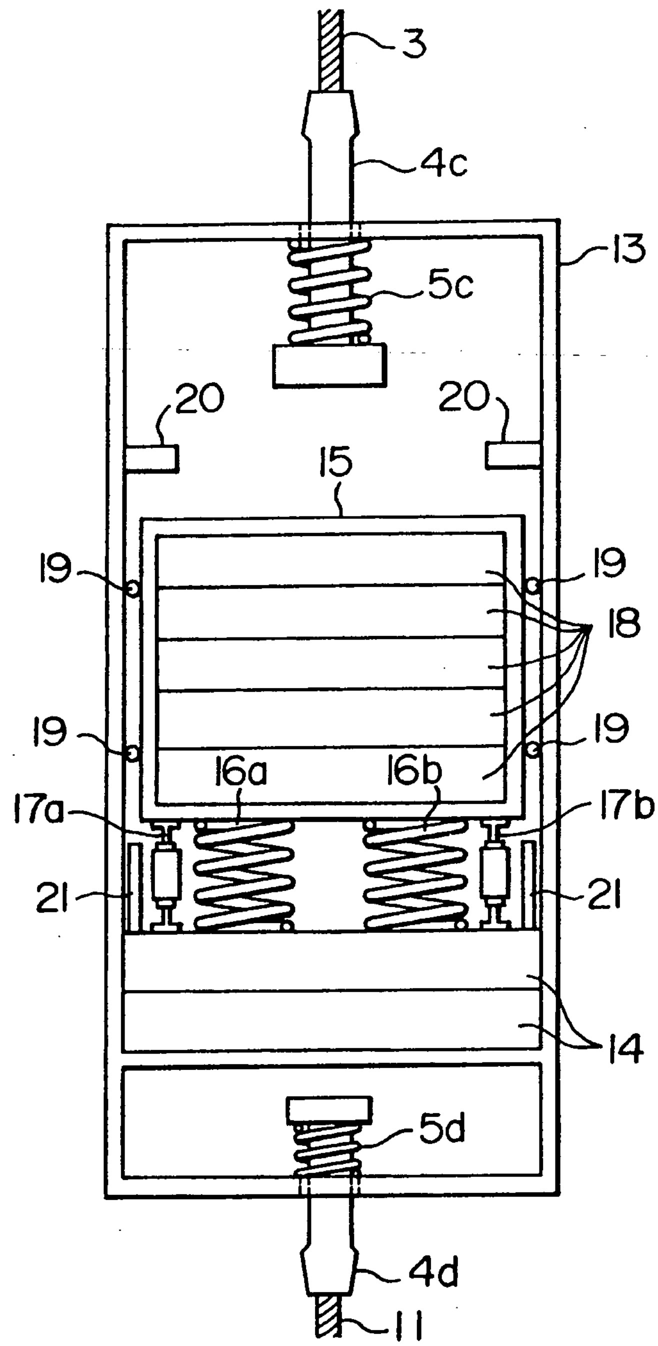


FIG. 13

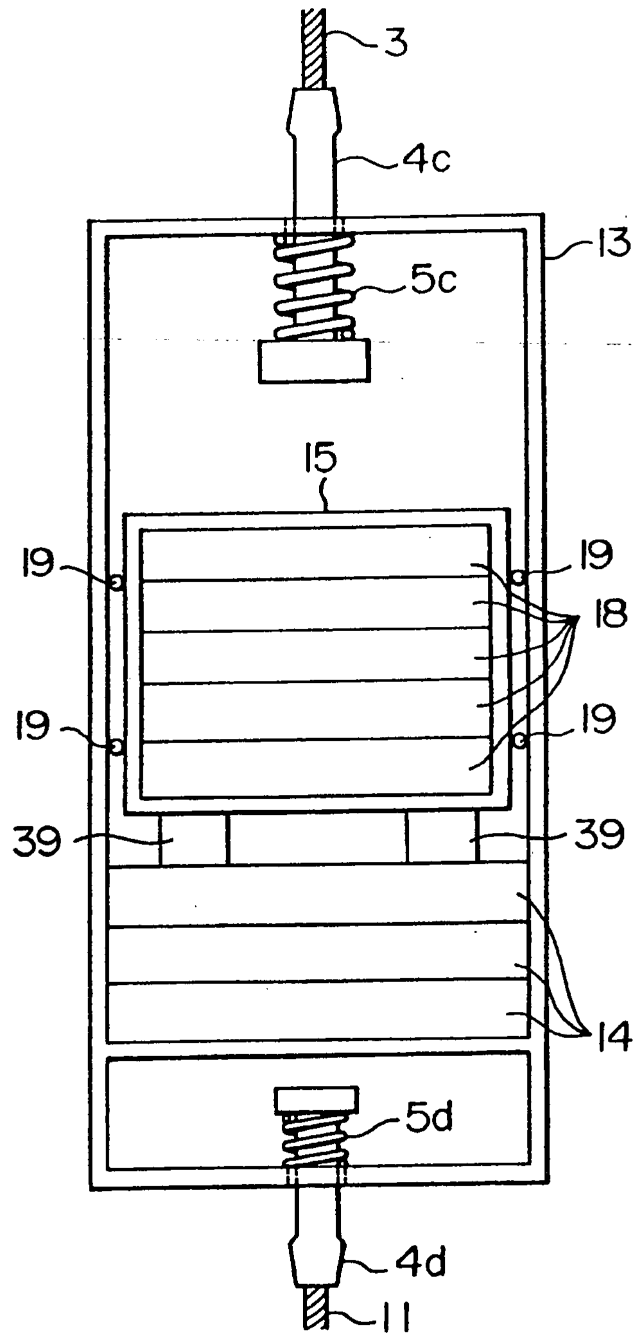


FIG. 14

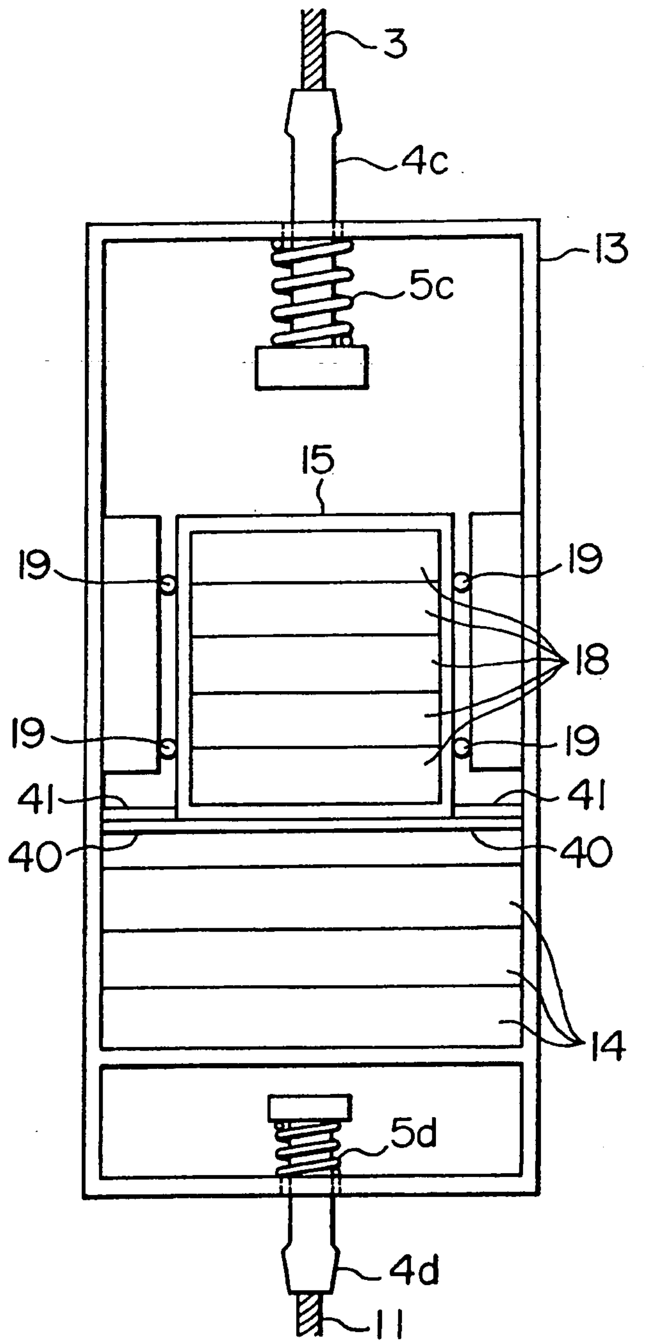


FIG. 15

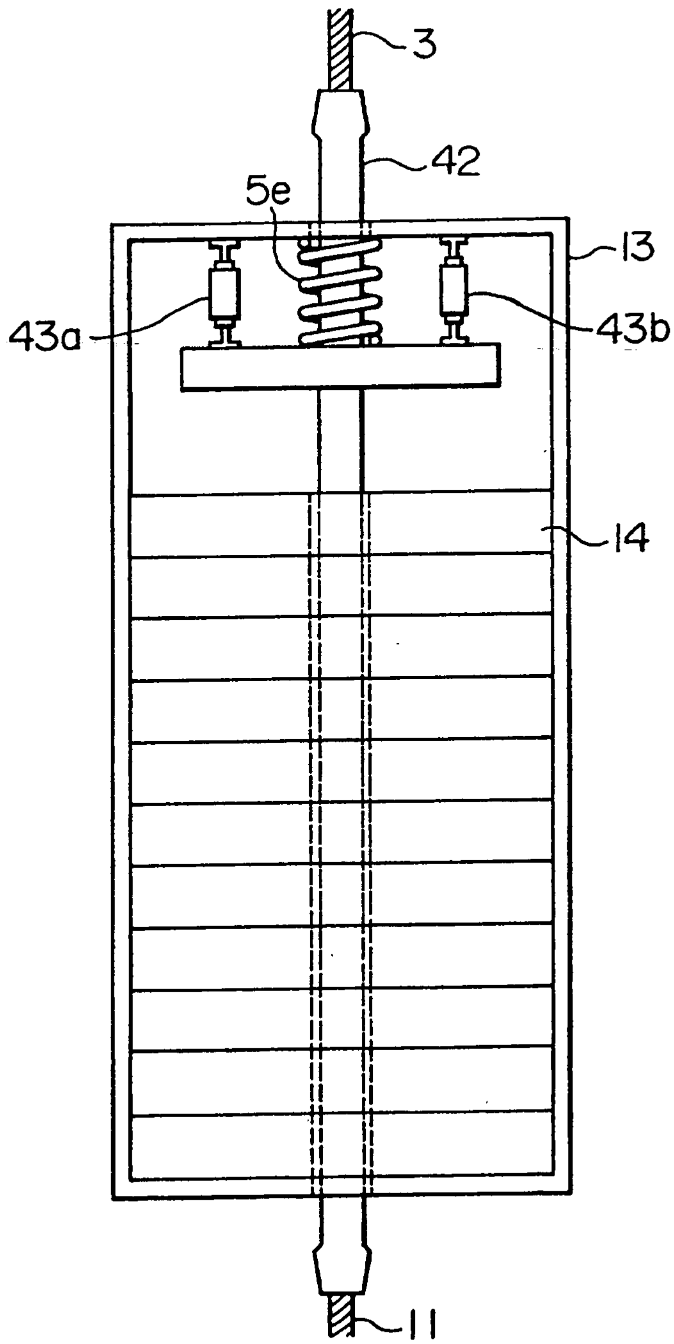
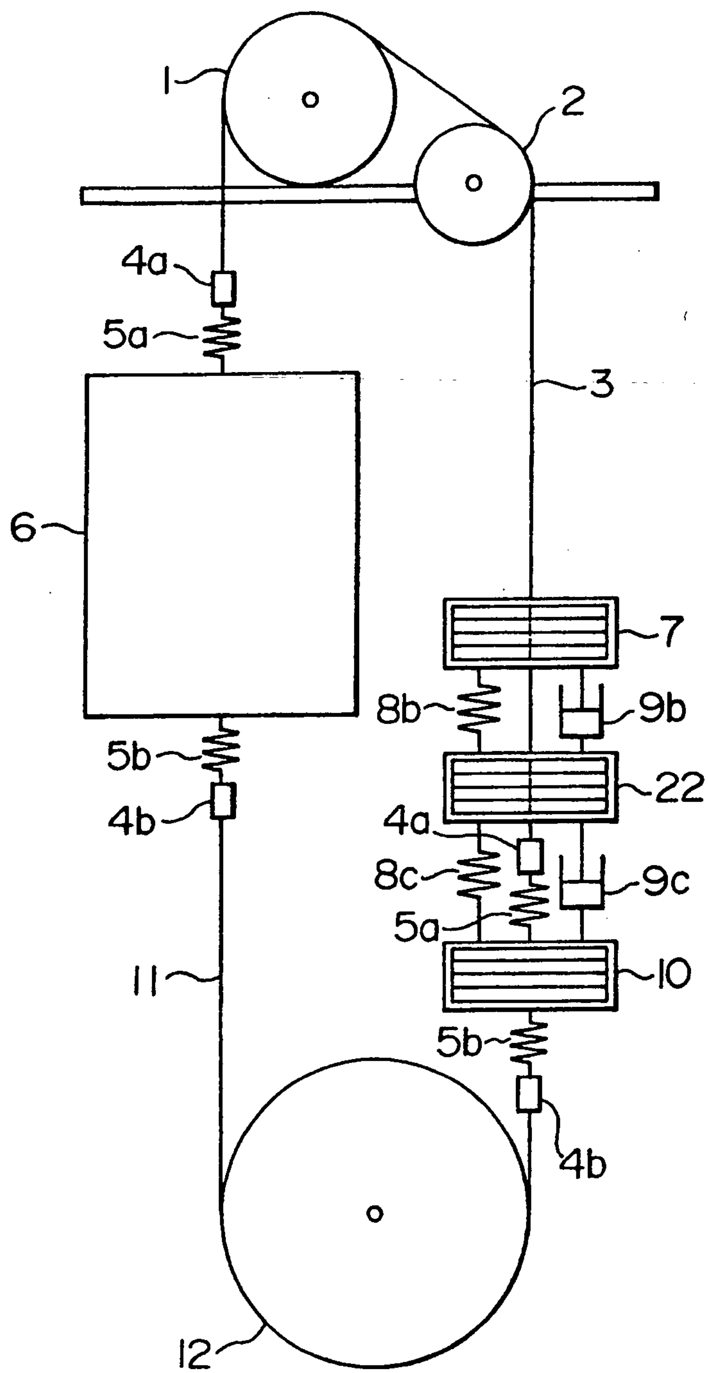


FIG. 16



BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a vibration preventing device for elevator, and more specifically, to an elevator vibration preventing device preferable for reducing the vibration in the operational direction of a passenger cage of elevator.

DESCRIPTION OF THE PRIOR ART

In general, an elevator apparatus is operated upward and downward in such a manner that a passenger cage and a counterweight are connected to the opposite ends of a main rope, which is trained around the sheave of a hoisting machine, by a rod through an elastic member such as a spring or the like and the torque of the hoisting machine is controlled, the hoisting machine having a speed controlled by a controller. When the elevator has an increased stroke, however, the weight of the main rope is unbalanced depending upon the location of the passenger cage, by which the effective load on the hoisting machine is changed. To minimize the load on the hoisting machine, a compensating rope is attached to the lower sides of the passenger cage and the counterweight by a rod through an elastic member such as a spring or the like and trained around a compensating pulley. This elevator apparatus includes a case in which the speed

control system of the hoisting machine is unstable and a case in which the riding comfort of passengers is injured, depending upon the behaviors of the vibration mode of the vibration in the operational direction (hereinafter, referred to as upward/downward vibration) of the mechanical system of elevator caused by the elasticity of the main rope, the rotational inertia of the hoisting machine, and the masses of the passenger cage, counterweight and main rope. Japanese Patent Unexamined Publication No. 61-27884 discloses a prior art for damping the upward/downward vibration system. According to this prior art, a dynamic vibration absorber is provided to the thimble rod portion of an end of a main rope.

When the rope is vibrated at about 10 Hz or higher in the mechanical system of elevator, the thimble rod is also vibrated, and thus the prior art providing the dynamic vibration absorber to the thimble rod portion is effective to suppress the vibration of the rope. More specifically, the prior art can effectively damp the vibration in the vibration mode in which a compensating pulley moves upward and downward. Recently, however, as the height of buildings is increased, the stroke of elevators is increased. As the stroke is increased, the natural frequency of vibration of the mechanical system of elevator is lowered, and thus it is difficult to stably control the driving control system thereof. In particular, it is an important problem to reduce the

vibration mode caused by the rotation of a compensating pulley and sheave among the vibration modes of the mechanical system of elevator.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a vibration preventing device for elevator, which is applied to a high-rise building, capable of reducing a vibration mode caused by the rotation of a compensating pulley and a sheave, which vibration mode is contemplated to be most difficult to be provided with a vibration suppressing mechanism among the vibrations caused in the mechanical system of an elevator as a whole.

To achieve the above object, a vibration preventing device for elevator according to the present invention has a sheave provided with an output shaft of a hoisting machine, a deflector wheel disposed on the side of the sheave, a main rope trained around the sheave and the deflector wheel, the main rope having one end connected to the upper side of a passenger cage and the other end thereof connected to the upper side of a counterweight, and a compensating rope attached to the lower sides of the passenger cage and the counterweight being trained around a compensating pulley, characterized in that the counterweight includes a vibration damping means for suppressing the vibration mode caused by the rotation of the sheave and the compensating pulley.

In the aforesaid vibration preventing device

for elevator, the counterweight includes at least two separate mass members and these mass members are connected to each other by an elastic member(s) and a damping member(s) as the vibration damping means.

Since the counterweight is divided and the divided counterweights are connected to each other by the elastic member, they produces a relative mode displacement difference therebetween and reduces the mode displacement of the rotational vibration mode with respect to the vibration mode in which the compensating pulley or sheave of the mechanical system of elevator is rotationally vibrated. Further, the rotational vibration mode can be reduced in such a manner that the elastic member between the counterweights is made of a material softer than the rope and the thimble rod spring to increase the relative mode displacement difference between the counterweights in the rotational vibration mode. Further, the vibration of the counterweights can be reduced by connecting the counterweights having an increased relative mode displacement difference by a damping member having a suitable damping coefficient.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plane view of an elevator apparatus provided with a vibration preventing device according to an embodiment of the present invention;

Fig. 2 is a plane view of a vibration preventing device of another embodiment according to the present

invention;

Fig. 3 is a vibration mode diagram showing an effect of an elevator apparatus provided with the device of Fig. 1;

Fig. 4 is a frequency characteristic diagram showing an effect of the elevator apparatus provided with the device Fig. 1;

Fig. 5 is a plane view of the elevator apparatus provided with a vibration preventing device according to a still another embodiment of the present invention;

Fig. 6 is a plane view of the elevator apparatus provided with a vibration preventing device according to another embodiment of the present invention.

Fig. 7 is a plane view of the elevator apparatus provided with a vibration preventing device according to a still another embodiment of the present invention;

Fig. 8 is a plane view of the elevator apparatus provided with a vibration preventing device according to another embodiment of the present invention;

Fig. 9 is a plane view of the elevator apparatus provided with a vibration preventing device according to a still another embodiment of the present invention;

Fig. 10 is a plane view showing a vibration preventing device according to another embodiment of the present invention;

Fig. 11 is a plane view showing a vibration preventing device according to a still another embodiment of the present invention;

Fig. 12 is a plane view showing a vibration preventing device according to another embodiment of the present invention;

Fig. 13 is a plane view showing a vibration preventing device according to a still another embodiment of the present invention;

Fig. 14 is a plane view showing a vibration preventing device according to another embodiment of the present invention;

Fig. 15 is a plane view showing a vibration preventing device according to a still another embodiment of the present invention; and

Fig. 16 is a plane view showing a vibration preventing device according to another embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Embodiments of the present invention will be described below with reference to the drawings.

Fig. 1 shows an elevator provided with a vibration preventing device according to an embodiment of the present invention. In this embodiment, a counter-weight is divided into two portions. Usually, although two or more ropes are used, the embodiment will be described by simplifying the ropes to a single one.

Further, a compensating rope may be a compensating chain. Numeral 1 denotes a sheave provided with the output shaft of a hoisting machine, numeral 2 denotes a deflector wheel disposed on the side of the sheave 1, numeral 3 denotes a main rope trained around the sheave 1 and deflector wheel 2. The ends of the main rope are connected to a passenger cage 6 and a first counterweight 7, respectively, by a thimble rod spring 5a or a compression spring through a thimble rod 4a or a rope socket with a rod. A second counterweight 10 is connected to the first counterweight 7 through an elastic member 8a and a damper 9a. Further, a compensating rope 11 is connected to the lower sides of the passenger cage 6 and second counterweight 10 by a thimble rod spring 5b or a compression spring through a thimble rod 4b or a rope socket with a rod. The compensating rope 11 is trained around a compensating pulley 12. The elastic member 8a disposed between the counterweights 7, 10 has an elastic coefficient set to increase a relative displacement between the two counterweights 7, 10 at a frequency at which the sheave 1 is rotationally vibrated and further the damper 9a disposed between the counterweights 7, 10 has a damping coefficient set to an optimum value for suppressing the rotational vibration thereof to thereby reduce the rotational vibration.

A specific arrangement of the counterweight will be described by using Fig. 2. A first counterweight frame 13 is suspended from the main rope 3 by a thimble

rod spring 5c through a thimble rod 4c. First counterweights 14 are fixed in the first counterweight frame 13. Further, a second counterweight frame 15 is connected to the first counterweights 14 through coil springs 16a, 16b and oil dampers 17a, 17b. The coil springs 16a, 16b and the oil dampers 17a, 17b are disposed symmetrically with respect to the center axis in the upward/downward direction of the counterweight so that they have a structure making it difficult to produce a torsional vibration. Further, second counterweights 18 are fixed in the second counterweight frame 15. Here, the second counterweight frame 15 is connected to the first counterweight frame 13 through rollers 19 and can move only in the upward/downward direction, and the range in which the second counterweight frame 15 can move is suppressed by buffer members 20, 21. Further, the second counterweight frame 15 is connected to the compensating rope 11 by a thimble rod spring 5d through a thimble rod 4d passing through the fist counterweight.

Figs. 3 and 4 are diagrams explaining the vibration preventing device of the elevator shown in Figs. 1 and 2. A disturbance producing vibration to the mechanical system of the elevator shown in Figs. 1 and 2 includes a sheave torque, variation of the number of passengers in the passenger cage, disturbance of the rails for guiding the passenger cage, and the like. The respective portions of the mechanical system of the elevator shown in Fig. 1 are vibrated by these

disturbances. More specifically, the upward/downward vibration of the passenger cage and counterweights, the upward/downward and rotational vibration of the compensating pulley 12, and rotational vibration of the sheave 1 are caused. It is difficult to provide a vibration control mechanism in the rotating direction of the sheave 1 without preventing the operation of the elevator with respect to the rotational vibration of the sheave 1 among these vibrations. Further, on the other hand, although the passenger cage of the elevator moves from the uppermost stair to an intermediate stair and to the lowermost stair therefrom, when the passenger cage is particularly at the intermediate stair, the mechanical system of the elevator is symmetrical with respect to right and left directions, and it is at this time that a vibration is produced to cause a large rotational vibration to the sheave 1. Fig. 3 shows the result obtained by calculating numerical values in the vibration mode diagram of the vibration mode in which the sheave 1 is rotationally vibrated in a large amount among the vibration modes of the mechanical system of the elevator, wherein the abscissa shows the respective portions of the mechanical system of the elevator and the ordinate shows a mode displacement normalized by a maximum value 1. In Fig. 3, (a) shows the vibration mode in which the damper between the counterweights has a damping coefficient 0 in the elevator with a large mode displacement difference set between the first balance weigh and the second

counterweight. For comparison, Fig. 3 also shows the vibration mode (b) of the elevator in which the counter-weight is not divided. In the vibration mode (b) in which the counterweight is not divided, the first counterweight is connected to the second counterweight through a rigid body in the figure and thus they have the same mode displacement. When the counterweight is divided, however, a mode displacement difference is caused between the counterweights, and thus the effect of the damper between the counterweights can be obtained. Further, the elastic member between the counterweights is composed of a member having an elastic coefficient smaller than those of the ropes and thimble rod spring to thereby increase the mode displacement difference between the first and second counterweights, whereas the mode displacement of the rotational vibration of the sheave is reduced by dividing the counterweight. Further, as shown in Fig. 3, (c) in Fig. 4 shows the result obtained by calculating the numerical values of vibration characteristics in which a damping coefficient of the damper between the counterweights is optimized in the elevator provided with the elastic member (Fig. 1). In Fig. 4, (d) shows the vibration characteristics of the elevator in which the counterweight is not divided. Note, the frequency of the rotational vibration mode of the sheave desired to reduce is shown by (e) in Fig. 4 and the use of the counterweight divided into the two portions provides a vibration control effect of about 20 dB.

Fig. 5 shows another embodiment of the device according to the present invention, wherein a third counterweight 22 is connected to a first counterweight 7 through an elastic member 8b and a damper 9b and further a second counterweight 10 is connected to the third counterweight 22 through an elastic member 8c and a damper 9c.

This embodiment operates in the same way as the embodiment shown in Fig. 1, and in particular the third counterweight 22 operates substantially in the same way as the first counterweight or the second counterweight. With this arrangement, however, a mass dividing ratio of the first and second counterweights and parameters of a spring constant and damping constant can be set in a wider range.

Fig. 6 shows a still another embodiment of the device according to the present invention, wherein a passenger cage 6 and a first counterweight frame 23 are suspended from a main rope 3 by a thimble rod spring 5a through a thimble rod 4a and a first counterweight 24 is fixed in the first counterweight frame 23. Further, a second counterweight frame 28 is connected to the first counterweight frame 23 by a rod 27 through a coil spring 25 and oil dampers 26a, 26b, and a second counterweight 29 is fixed within the second counterweight frame 28 thereto. Here, the oil dampers 26a, 26b are disposed symmetrically with respect to the center axis in the upward/downward direction of the counterweights so that

they have a structure difficult to produce a torsional vibration.

According to this embodiment, although the same vibration system as that of the embodiment shown in Fig. 1 is arranged, a production cost can be reduced by providing the two counterweights with the same arrangement and further the vibration system of elevator having the counterweight divided into two portions shown in Fig. 1 can be embodied without causing any loss.

Fig. 7 shows another embodiment of the device according to the present invention, wherein an hydraulic actuator 30 is disposed between a first counterweight 7 connected to a main rope 3 by a thimble rod spring 5a through a thimble rod 4a and a second counterweight 10 connected to a compensating rope 3 by a thimble rod spring 5b through a thimble rod 4b. Further, acceleration sensors 31 are disposed on the first and second counterweights 7, 10 to sense the acceleration in the upward/downward direction thereof. Signals sensed by these acceleration sensors 31 are converted into control command signals by a controller 32 and drives the hydraulic actuator 30 to effect the active vibration prevention control of the counterweights. In the controller 32, the signals sensed by the acceleration sensors 31 are amplified by amplifiers 33a and multiplied by a control gain 34, and further the operating state of the hydraulic actuator such an amount of displacement and the like is also amplified and fed back by an amplifier

33b to adjust the control gain in accordance with the sensed signals thereof. When the passenger cage moves from the uppermost stair to the lowermost stair, the counterweights also move from a lower position to an upper position and thus an elastic member 8a is extended by an increase in weight of the counterweight on the side of the compensating rope 11. In this controller, a control in accordance with the position of the counter-weights can be effected by also feeding back an amount of extension of the elastic member 8a, i.e., a static operating condition of the hydraulic actuator through the amplifier 33b.

Fig. 8 shows a still another embodiment of the device according to the present invention, wherein a hydraulic actuator 30 is disposed between a first counterweight 7 connected to a main rope 3 and a compensating rope 11 by thimble rod springs 5a, 5b through thimble rod 4a, 4b and a second counterweight 10. Further, an acceleration sensors 31 are disposed on the first and second counterweights 7, 10 to sense the acceleration in the upward/downward direction thereof. Signals sensed by these acceleration sensors 31 are converted into control command signals by a controller 32 and drives the hydraulic actuator 30 to effect the active vibration prevention control of the counterweight. In the controller 32, the signals sensed by the acceleration sensors 31 are amplified by amplifiers 33a and multiplied by a control gain 34, and further the operating state of

the hydraulic actuator such an amount of displacement and the like is also amplified and fed back by an amplifier 33b to adjust the control gain in accordance with the sensed signals thereof to effect a control in association with a vibration system.

Fig. 9 shows another embodiment of the device according to the present invention composed of a 1 : 2 roping elevator apparatus having a counterweight divided into two portions. In this embodiment, a main rope 3 trained around a sheave 1 supported by the output shaft of a hoisting machine and a deflector wheel 2 is lifted up again by being trained around a pulley 37 provided with a connecting member 36 and connected to a passenger cage 6 through an elastic member 35 and a pulley 37 provided with a connecting member 36 and connected to a counterweight frame 13 through an elastic member 35 and further the opposite ends of the main rope 3 are fixed to a machine room through elastic members 38. First and second counterweights 14, 18 in the counterweight frame 13 are connected to each other by an elastic member 8d and a damper 9d.

This embodiment is an arrangement having a dynamic vibration absorber provided with the first counterweight 14 and the vibration of the mechanical system of the elevator can be reduced at a frequency set by the auxiliary vibration system composed of the second counterweight 18, elastic member 8d and damper 9d.

Fig. 10 shows a still another embodiment of the

device according to the present invention, wherein a second counterweight frame 15 is connected to a first counterweight 14 by a rubber cushion 39. Although Fig. 10 is a specific arrangement diagram of Fig. 1 similar to the embodiment shown in Fig. 2, a space where an elastic member is disposed is reduced by composing the elastic member of the rubber cushion 39 to make a design easy. Further, in the embodiment shown in Fig. 11, a second counterweight frame 15 is fixed on the leaf spring 40 fixed to a first counterweight frame 13. In addition, a damping member 41 is bonded on the leaf spring 40. Although Fig. 11 is also a specific arrangement diagram of Fig. 1 similar to the embodiment shown in Fig. 2, when a second counterweight 18 has a relatively small mass, a space where an elastic member is disposed can be further reduced by the leaf spring 40.

Figs. 12 to 14 show other embodiments of the device according to the present invention, respectively. In these embodiments, a first counterweight frame 13 having a two-stage structure and connected to a main rope 3 by a thimble rod spring 5c through a thimble rod 4c is connected to a compensating rope 11 by a thimble rod spring 5d through a thimble rod 4d. A second counterweight has the structure of a dynamic vibration absorber as a mass added to a first counterweight. This arrangement can be applied to an elevator apparatus without a compensating rope 11. In the embodiment shown in Fig. 12, a second counterweight frame 15 is connected to a

first counterweight 14 by coil springs 16a, 16b and oil dampers 17a, 17b. Further, in the embodiment shown in Fig. 13, a second counterweight frame 15 is connected to a first counterweight 14 by rubber cushions 39. Further, in the embodiment shown in Fig. 14, a second counterweight frame 15 is fixed on a leaf spring 40 fixed to a first counterweight frame 13. Further, a damping member 41 is bonded on the leaf spring 40.

These embodiments are arranged to dispose the dynamic vibration absorber to the first counterweight 14 and the vibration of the mechanical system of an elevator can be reduced at a frequency set by the auxiliary vibration system composed of the second counterweight 18, elastic member and damper.

Fig. 15 shows a still another embodiment of the device according to the present invention, wherein a main rope 3 is connected to a compensating rope 11 by a connecting member 42 to which a counterweight frame 13 is fixed through a thimble rod spring 5e and oil dampers 43a, 43b, which is a special case for maximizing an additional mass of a dynamic vibration absorber to achieve a maximum effect.

Further, Fig. 16 shows a still another embodiment of the device according to the present invention, wherein a second counterweight 10 is connected to a main rope 3 passing through a first counterweight 7 and a third counterweight 22 and a compensating rope 11, and further the third counterweight 22 is connected to the

second counterweight 10 through an elastic member 8c and a damper 9c, and further the first counterweight 7 is connected to the third counterweight 22 through an elastic member 8b and a damper 9b. In this elevator apparatus, the third counterweight 22 operates substantially in the same way as the first counterweight 7 or the second counterweight 10. With this arrangement, however, a mass dividing ratio of the first and second counterweights and parameters of a spring constant and damping constant can be set in a wider range.

According to the present invention, the rotational vibration of the sheave and compensating pulley of the mechanical system of an elevator can be reduced, a driving control system can be stabilized and further the riding comfort of passengers can be improved by dividing a counterweight and connecting divided counterweights by a spring(s) and a damper(s).

WHAT IS CLAIMED IS:

1. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, the main rope is connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod, and a compensating rope is attached to lower sides of the passenger cage and the counterweight and trained around a compensating pulley, wherein said counterweight includes a vibration damping means for suppressing a vibration mode caused by rotation of said sheave and said compensating pulley.

2. A vibration preventing device for elevator according to Claim 1, wherein said vibration damping means includes an elastic member and a damping member for connecting a plurality of mass members of said counterweight to each other.

3. A vibration preventing device for elevator according to Claim 1, wherein said vibration damping means includes at least one vibration-proof rubber for connecting the plurality of mass members of said counterweight to each other.

4. A vibration preventing device for elevator according to Claim 1, wherein said vibration damping means includes a plate member such as a leaf spring or the like having elasticity in the upward/downward direction, fixed to mass members movable in a frame of

said counterweight and also fixed to said frame.

5. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, an end of the main rope is connected to one side of a passenger cage and the other end thereof is connected to one end of a counterweight, and a compensating rope connected to the lower sides of the passenger cage and the counterweight is trained around a compensating pulley, wherein said counterweight includes at least two separately provided mass members and said mass members are connected to each other by an elastic member(s) and a damping member(s).

6. A vibration preventing device for elevator according to Claim 5, wherein one of said mass members forming said counterweight is connected to said main rope by a thimble rod spring through a thimble rod, other one of said mass members is connected to said compensating rope by a thimble rod spring through a thimble rod, and said both mass members are connected to each other through an elastic member(s) and a damping member(s).

7. A vibration preventing device for elevator according to Claim 5, wherein said main rope is connected to one of said mass members forming said counterweight by a thimble rod spring through a thimble rod, said compensating rope is connected to other side of said mass members by a thimble rod spring through a thimble rod, and said other mass member is connected to said mass

members through an elastic member(s) and a damping member(s).

8. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, an end of the main rope is connected to one side of a passenger cage and other end thereof is connected to one end of a counterweight, and a compensating rope connected to lower sides of the passenger cage and the counterweight is trained around a compensating pulley, wherein said counterweight includes two separately provided mass members, one of said mass members is connected to said main rope by a thimble rod spring through a thimble rod, and said one of said mass members is connected to other one of said mass members through a still another mass member, elastic members and damping members.

9. A vibration preventing device for elevator according to Claim 8, wherein one of the mass members forming said counterweight is connected to said main rope by a thimble rod spring through a thimble rod, the other one of said mass members is connected to said compensating rope by a thimble rod spring through a thimble rod, and said both mass members are connected to each other through a still another mass member, elastic members and damping members.

10. A vibration preventing device for elevator according to Claim 8, wherein said main rope is connected

to one of said mass members forming said counterweight by a thimble rod spring through a thimble rod, said compensating rope is connected to other side of said mass members by a thimble rod spring through a thimble rod, and a still another mass member is connected to said respective mass members through a still mass members elastic members and damping members.

11. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, the main rope is connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod, a compensating rope is connected to lower sides of the passenger cage and the counterweight and trained around a compensating pulley, wherein said counterweight includes two separately provided mass members, one of said mass members is connected to said main rope by a thimble rod spring through a thimble rod, other one of said mass members is connected to a compensating rope by a thimble rod spring through a thimble rod, and said both mass members are connected to each other by at least one elastic member and at least one damper.

12. A vibration preventing device for elevator according to Claim 11, wherein said both mass members are connected to each other through at least one elastic member having an elastic coefficient smaller than those

of said ropes and said thimble rod spring and through at least one damping member.

13. A vibration preventing device for elevator according to Claim 11, wherein said elastic member includes a coil spring.

14. A vibration preventing device for elevator according to Claim 11, wherein said damping member includes an oil damper.

15. A vibration preventing device for elevator according to Claim 11, wherein said mass member connected to said main rope by said thimble rod spring through said thimble rod includes a counterweight and a mass member connected to a counterweight frame, and said mass member connected to said compensating rope by said thimble rod spring through said thimble rod is located in said counterweight frame and movable with respect to said counterweight frame.

16. A vibration preventing device for elevator according to Claim 15, wherein a buffer member is disposed on said counterweight frame to restrict a movable region of said mass member movable in said counterweight frame.

17. A vibration preventing device for elevator according to Claim 15, wherein said both mass members are connected to each other through at least one cushion rubber.

18. A vibration preventing device for elevator according to Claim 15, wherein said mass member movable

in said counterweight frame is fixed to a plate-shaped spring member fixed to said counterweight frame.

19. A vibration preventing device for elevator according to Claim 15, further comprising sensors on said both mass members for sensing an amount of vibration in the upward/downward direction of said both mass members, a conversion unit for converting the amount of vibration sensed by said sensors into control command signals, and a drive unit for producing a control force in the upward/downward direction of said counterweight between said both mass members.

20. A vibration preventing device for elevator according to Claim 19, wherein said sensors include displacement sensors for sensing a relative position in an elevator operational direction between said both mass members.

21. A vibration preventing device for elevator according to Claim 19, wherein said sensors include acceleration sensors for sensing acceleration in an elevator operational direction on said both mass members.

22. A vibration preventing device for elevator according to Claim 19, wherein said drive unit include a hydraulic actuator for generating a control force in an elevator operational direction between said both mass members.

23. A vibration preventing device for an elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a

deflector wheel disposed on a side of the sheave, the main rope is connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod, a compensating rope is attached to lower sides of the passenger cage and the counterweight and trained around a compensating pulley, wherein a mass member forming said counterweight is connected to a main rope and a compensating rope by a thimble rod spring through a thimble rod, and another mass member is connected to said mass member through at least one elastic member and at least one damping member.

24. A vibration preventing device for elevator according to Claim 23, wherein said mass member connected to said main rope and said compensating rope by said thimble rod spring through said thimble rod includes a mass member fixed to a counterweight frame, and a separate mass member is located in said counterweight frame and movable with respect to said counterweight frame.

25. A vibration preventing device for elevator according to Claim 24, wherein a buffer member is disposed on said counterweight frame to restrict a movable region of said mass member movable in said counterweight frame.

26. A vibration preventing device for elevator according to Claim 24, wherein said both mass members are connected to each other through at least one vibration-proof rubber.

27. A vibration preventing device for elevator according to Claim 24, wherein said mass member movable in said counterweight frame is fixed to a plate-shaped spring member having elasticity in the upward/downward direction and fixed in said counterweight frame.

28. A vibration preventing device for elevator according to Claim 24, further comprising sensors on said both mass members for sensing an amount of vibration in upward/downward direction of said both mass members, a conversion unit for converting the amount of vibration sensed by said sensors into control command signals, and a drive unit for producing a control force in the upward/downward direction of said counterweight between said both mass members.

29. A vibration preventing device for elevator according to Claim 28, wherein said sensors include displacement sensors for sensing a relative position in an elevator operational direction between said both mass members.

30. A vibration preventing device for elevator according to Claim 28, wherein said sensors include acceleration sensors for sensing accelerations in an elevator operational direction on said both mass members.

31. A vibration preventing device for elevator according to Claim 28, wherein said drive unit include a hydraulic actuator for generating a control force in an elevator operational direction between said both mass members.

32. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, the main rope is connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod, a compensating rope is attached to lower sides of the passenger cage and the counterweight and trained around a compensating pulley, wherein a mass member forming said counterweight is connected by an elastic member and a damping member located at the portion where said main rope is connected to said compensating rope.

33. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, ends of said main rope are connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod, and a compensating rope is connected to lower sides of the passenger cage and the counterweight by a rod through an elastic member such as a spring or the like, wherein said counterweight includes one mass member and another mass member, said one mass member is connected to said main rope by a thimble rod spring through a thimble rod, said another mass member is connected to said compensating rope by a thimble rod spring through a thimble rod, and said two mass members

are connected to each other through at least one elastic member and at least one damping member.

34. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, ends of said main rope are connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod and a compensating chain is connected to lower sides of said passenger cage and said counterweight by a rod through an elastic member such as a spring or the like, wherein said counterweight includes one mass member and another mass member, said one mass member is connected to said main rope by a thimble rod spring through a thimble rod, said another mass member is connected to said compensating chain by a thimble rod spring through a thimble rod, and said two mass members are connected to each other through at least one elastic member and at least one damping member.

35. A vibration preventing device for elevator in which a main rope is trained around a sheave provided with an output shaft of a hoisting machine and a deflector wheel disposed on a side of the sheave, ends of said main rope are connected to upper sides of a passenger cage and a counterweight, respectively, by a thimble rod spring through a thimble rod, and a compensating chain is attached to lower sides of the passenger cage and the counterweight by a thimble rod spring through a thimble

rod and trained around a compensating pulley, wherein said counterweight includes one mass member and another mass member, said one mass member is connected to said main rope by a thimble rod spring through a thimble rod, said another mass member is connected to said compensating chain by a thimble rod spring through a thimble rod and said two mass members are connected to each other by at least one elastic member and at least one damping member.

36. A vibration preventing device for an elevator substantially as herein described with reference to and as shown in Figs. 1-4 or each of Figs. 5-16 of the accompanying drawings.

Paten's Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

GB 9316482.0

Relevant Technical fields

(i) UK Cl (Edition L) B8B (BOD, BGC), B8L (LFP)

(ii) Int Cl (Edition 5) B66B

Search Examiner

M J DAVEY

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Date of Search

16 SEPTEMBER 1993

Documents considered relevant following a search in respect of claims 1 TO 36

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 1584475 (OTIS)	1
A	GB 1440895 (HITACHI)	1

SF2(p) ms - doc99\fil002248

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